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WATER RESOURCES STUDY. CLIFTY CREEK RESERVOIR WABASH RIVER BASIN, INDIANA

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
CHARLOTTESVILLE, VIRGINIA

PREPARED FOR
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LOUISVILLE, KENTUCKY

JANUARY 1964

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WATER RESOURCES STUDY
CLIFTY CREEK RESERVOIR
WABASH RIVER BASIN
INDIANA

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A Preliminary Study of Potential Needs and Value of Water for Municipal, Industrial, and Water Quality Control Purposes

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region III
Charlottesville, Virginia

JANUARY 1964

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WATER RESOURCES STUDY
CLIFTY CREEK RESERVOIR
WABASH RIVER BASIN
INDIANA

A Preliminary Study of Potential Needs and Value of Water for Municipal, Industrial, and Water Quality Control Purposes

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region III
Ohio River Basin Project
Evansville Field Station, Indiana

In Cooperation With The

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U. S. Army Engineer District - Louisville, Kentucky

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I. INTRODUCTION

Authority

The authority to conduct studies of need and value of water for municipal, industrial, and water quality control purposes is provided in the Federal Water Pollution Control Act (Public Law 84-660, as amended by Public Law 87-88 in 1961) and in the Memorandum of Agreement, dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare, relative to the Water Supply Act of 1958 (Title III of P.L. 85-500, as amended by P.L. 87-88).

In accordance with the above acts, the District Engineer, Corps of Engineers, Louisville, Kentucky, by letter dated August 20, 1963, requested the U. S. Public Health Service to furnish "...information in accordance with the work plan now under negotiation for your studies for the Wabash Basin Comprehensive Study...." The letter further stated "Deletion of the minimum pool at Clifty Creek will be considered because of the site's limited storage capability...unless you consider conservation storage to have greater value than flood control space...."

Purpose and Scope

This report assesses municipal and water supply needs for the Clifty Creek Basin in the counties of Bartholomew, Decatur, Rush, and Shelby Counties in Indiana, assesses surface water quality control needs, and estimates need for and value of water storage for regulation of the Clifty Creek flow for these needs for the years 1976 and 2010.

Due to time limitations, this study of the Clifty Creek Reservoir and its findings are considered to be preliminary and may require additional investigations and refinement prior to construction of the proposed project.

Acknowledgments

Completion of this study was made possible by the cooperation and assistance of Federal and State authorities and by local authorities in the basin. Information and data were furnished from their publications, records, and files.

Acknowledgment is made to the following agencies and their support is gratefully recognized:

U. S. Geological Survey

U. S. Soil Conservation Service

Indiana State Board of Health

Indiana Flood Control and Water Resources Commission

Wabash River Interstate Commission

City of Columbus

II. SUMMARY AND CONCLUSIONS

Summary

1. The proposed Clifty Creek Reservoir site is situated on Clifty Creek about 1½ miles southwest of Hartsville and about 10 miles northeast of Columbus, Indiana.

2. Clifty Creek, which has a drainage area of about 200 square miles, is a tributary of the East Fork, White River and enters that stream at a point just south of Columbus. The mean flow of the creek at a point where the drainage area is 88.8 square miles was 106 cfs during 14 years of record from 1948 to 1962. During that period, zero flow was experienced at times during 1948, 1951-57, 1959, and 1961.

3. Communities near the proposed Clifty Creek Reservoir site are Greensburg, Hope, Hartsville, and Columbus. Of these, only Hartsville lies within the basin. Columbus, which is situated on the East Fork of White River, is growing rapidly eastward and will be affected to a greater degree than the other communities.

4. Seymour, about 27 miles downstream from Columbus, utilizes the river as its source of public water supply and requires a water quality suitable for that use.

5. The City of Greensburg is located on Sand Creek and would be expected to take its water supply from that source. The community of Hope is expected to require a source of supply. Even if it elects to take its supply from the proposed reservoir, the demand would be so small as to be insignificant with respect to storage computations.

Conclusions

1. It is expected that the population of the Columbus area (Columbus township including the city) will increase from about 30,000 in 1960 to about 40,000 by 1976 and about 73,000 by the year 2010.

2. It is expected that this area which used 3.5 mgd (million gallons per day) in 1960 will need from 7.0 to 8.0 mgd for municipal supplies and 3.5 to 4.0 mgd for industrial uses in 1976. By the year 2010, it is believed the needs for water will be about 14.6 to 16.4 mgd for municipal supplies and from 7.3 to 8.2 mgd for industrial purposes. This water can be obtained from the East Fork, White River in the event presently used well fields prove inadequate.

3. In addition to needs for municipal and industrial purposes, water will be needed in Clifty Creek and in the East Fork, White River for quality control. Water in the range of 6.5 to 7.2 mgd in 1976 and from 9.1 to 12.9 mgd in the year 2010 will be needed to assimilate adequately treated wastes introduced into Clifty Creek. This water can be obtained by an annual draft on storage of 11,000 acre-feet in the proposed Clifty Creek Reservoir. In addition, this released flow will augment the flow in the East Fork, White River so that a satisfactory water quality is maintained at Seymour.

4. No benefits of any significance can be attributed to storage for municipal and industrial water supply purposes.

5. Water released from the proposed Clifty Creek Reservoir seasonal pool in the amount indicated above in order to assure minimum discharges at the confluence of Duck Creek as shown in Table 14 would provide a savings of $1,885,000 to Columbus, Indiana (1963 Construction Cost Index). These savings are based upon the elimination of a force main, a lift station, and operation and maintenance costs of these facilities. In addition, benefits realized from increases in flow of the East Fork, White River during periods of natural low flow would have at least a minimum value of about $1,440,000 (1963 Construction Cost Index) based upon the cost of a single purpose reservoir which would assure the required flow in Clifty Creek. Amortized for 50 years at three percent and adjusted for operation and maintenance costs, these amounts are equivalent to annual values of $73,000 and $70,000 respectively, or a total value of $143,000 per year.

6. Flows released from the proposed Clifty Creek Reservoir could receive adequately treated wastes and provide water of satisfactory quality flowing through a residential area of East Columbus. It would improve the quality of water in the East Fork, White River thereby benefiting Seymour, Indiana by providing a better source of raw water supply. In addition, such flows would provide a quality of water which would enhance recreational opportunities and improve the aquatic environment in the East Fork, White River, the White River, and the Wabash River to the Ohio River.

III. DESCRIPTION OF PROJECT

Location

The Corps of Engineers is presently considering the Clifty Creek Basin as a possible site for a multi-purpose reservoir project. The proposed reservoir site under study is in Bartholomew and Decatur Counties, Indiana, on Clifty Creek, a tributary of East Fork of White River (See Figure I). Seventy percent (140 square miles) of the basin's total drainage area of 200 square miles is located above the proposed dam site. The dam site under consideration is approximately 18 stream miles above the mouth of Clifty Creek, 1½ miles southwest of Hartsville, Indiana, and about 10 miles east by northeast of Columbus, Indiana.

Streamflow

The average discharge[1] of Clifty Creek at Hartsville for 14 years of record (February 1948 to September 1962) is 106 cfs from a drainage area of 88.8 square miles. Maximum and minimum mean daily flows experienced during the period of record were 6,180 cfs and zero flow respectively. Records indicate that for the gaging station at Hartsville, there have been periods of prolonged zero flow. In fact, zero flow has occurred at times during 1948, 1951-57, 1959, and 1961. For the 1962 water year, the mean discharge was 79.8 cfs. The expected minimum 7 consecutive day flow with a frequency of recurrence of once in 10 years is zero based upon a study of past records.[2]

Water Quality

There have been no water quality sampling stations located on Clifty Creek, thus no information is available as to the actual quality of the water and for the purpose of this report, it is assumed Clifty Creek water will be of a similar quality to that of Big Blue River near Carthage, Muscatatuck River near Austin, and Laughery Creek near Osgood. Table 1[3] lists the results of analysis of samples collected at the above quality monitoring stations for the year 1962. These areas were selected because of their similarity and proximity to the Clifty Creek Basin. There are no municipal wastes (raw or treated) being discharged into Clifty Creek above the proposed dam site; therefore, it is mainly for this reason that the quality of the water is expected to be acceptable for all legitimate uses.

Before this information can be used in final design, the water quality of the stream must be determined by a program of sampling and analyses.

Pertinent Data

Storage volumes tentatively selected by the Corps of Engineers for the purpose of this study are as follows: minimum pool would provide 7,655 acre-feet of storage at elevation 705 feet and useable seasonal storage would provide 10,860 acre-feet of water at elevation 720 feet.*

*This seasonal water storage is a temporary storage provided in the lower part of the flood control pool in the summer months when flood control storage needs are less.

Table 1[3]

Water Quality Results*
Monitoring Stations near the
Clifty Creek Reservoir Project

Station	Big Blue River near Carthage			Laughery Creek near Osgood			Muscatatuck River near Austin		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Alkalinity as CaCO3	152	301	260	56	228	153	60	174	124
Chlorides as Cl	7	27	16	3	27	11	3	24	10
Nitrates as N	0.5	5.4	2.0	0.1	3.1	0.7	0.1	2.2	0.7
pH	7.3	8.6	8.1	7.5	8.8	8.2	7.0	8.3	7.8
Specific Conductance	421	1105	633	158	547	362	143	513	330
Hardness as CaCO3	173	370	315	88	290	178	74	214	150
Color	5	25	10	5	40	20	-5	50	15
Turbidity	5	700	55	5	500	50	5	600	65
Susp. Matter	2	588	56	3	422	41	5	845	71
Vol. Susp. Matter	0	108	14	0	42	10	0	76	12
BOD	0.6	7.7	2.3	0.5	6.2	2.8	1.3	9.3	3.2
DO	6.5	12.8	9.9	4.3	14.0	9.1	0.0	12.0	7.0

*Results from approximately 28 samples per station collected during the year 1962. All results are given in mg/l except pH, color, turbidity and specific conductance. The latter unit is in µmhos/cm.

The proposed seasonal pool would be filled in April and May each year and would be held at or as near as possible to 720 feet considering that water must be discharged from the reservoir as shown on Table 14. After Labor Day, the seasonal pool would be drained at a rate which would bring the water surface to the minimum pool elevation by December 1.

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The Clifty Creek Basin is located in the southeastern part of the State of Indiana, approximately 50 miles southeast of Indianapolis, and lies generally in a northeast and southwest direction (See Figure I). Clifty Creek has a watershed drainage area of 200 square miles in parts of four counties: Bartholomew, Decatur, Rush, and Shelby. The basin is about 40 miles in length and varies in width from 3 to 10 miles.

Formed by the merging of three streams (North Branch, Middle Branch, and South Branch) in its upper reaches, Clifty Creek extends southwesterly to its junction with the East Fork, White River just south of Columbus. One of the principal tributaries is Fall Fork, which enters Clifty Creek just above the proposed dam site. Duck Creek, another main tributary, enters the Clifty Creek about 5 miles downstream from the proposed dam. Another tributary, Otter Creek, enters Clifty Creek about 8 miles below the proposed dam site and south of the small community of Petersville.

Geography

The terrain of the Clifty Creek Basin is generally level to rolling. Near the mouth of the stream, the topography is moderately flat. Around Hartsville the terrain becomes moderately steep and gradually levels to rolling topography up to the confluence of the three tributary branches. The branches of the creek develop in moderately steep terrain.

Clifty Creek has a fall of about 320 feet in a distance of approximately 40 miles from its beginning at the confluence of the contributing branches to the junction with the East Fork, White River. More than 70 percent of this fall occurs above the community of Hartsville in a distance of about 20 miles.

Due to the above features, it is observed that Clifty Creek has one of the highest rates of runoff of any gaged stream in the Upper East Fork of the White River Basin.[4]

Climate

Temperatures[5] are fairly consistent throughout the basin. At the lower end of the drainage basin, based upon 78 years of record, Columbus has a mean annual temperature of 54.4°, a mean monthly high (July) of 76.5°, and a mean monthly low (January) of 32.4°. Near the upper end of the Clifty Creek Basin, Greensburg, with 65 years record, has a mean annual temperature of 53.4°, a mean monthly high (July) of 75.9°, and a mean monthly low (January) of 31.0°. The extreme low of 35.0° below zero was registered at Greensburg on February 2, 1951.

Precipitation records[5] for Columbus, based on 78 years of record, list a mean annual of 41.24 inches, a mean monthly high (June) of 4.12 inches, and a mean monthly low (October) of 2.51 inches. Greensburg, with 66 years of precipitation records, has experienced a mean annual precipitation of 41.06 inches, a mean monthly high (June) of 4.32 inches and a mean monthly low (August) of 2.57 inches.

Principal Communities and Industries

At the present time, only one incorporated community, Hartsville, is located within the Clifty Creek Basin. Hartsville borders on Clifty Creek and is approximately 20 stream miles from its mouth. The city of Columbus and the communities of Greensburg and Hope are located near to and will be affected by the proposed reservoir, therefore they are considered in this report. Columbus is situated near the mouth of Clifty Creek, and a southeast corner of the city lies within the basin. Hope is located 4 miles northwest of the proposed reservoir and just outside of the basin's drainage area. Greensburg is outside of the watershed and approximately 12 miles northeast of the proposed reservoir.

The majority of all industrial activity is located in or near the communities of Columbus and Greensburg with Columbus having the greater amount. An engine factory, an office furniture manufacturer, and a canning factory are some of the larger industries in Columbus. Greensburg has an aluminum and brass company and a packing plant.

V. ECONOMY

Present Economy

Area Included

The area of influence of the proposed Clifty Creek Reservoir Project includes all or part of six counties in southern Indiana. These six counties are: Bartholomew, Daviess, Jackson, Knox, Lawrence, and Martin.

Agriculture

Farming is important to the over-all economy of the study area. In 1960, agriculture accounted for 11,755 employees or 16.2 percent of all employment and this was a decrease of 2.6 percent from the 18.8 percent of 1950. In the State, agricultural employment had declined from 11.6 percent in 1950 to 6.5 percent in 1960. Value of farm products sold in the study area more than doubled between 1939 and 1959 as measured in constant dollars. The number of farms in the area declined but this was in line with the National trend toward the consolidation of farms into larger units.

Indices of Agricultural Activity
1939 - 1959

Year	Farms	%Change	Acres Harvested	% Change	Value of Products Sold*	% Change
1939	12,100	-59.0	590,000	+5.0	$26,300,000	+109.0
1959	5,000		620,000		$55,000,000	

*Expressed in constant monetary terms.

Mineral Industries

The mineral wealth of the study area consists of clays, coal, cement, gypsum, petroleum, natural gas, sand, stone, and gravel. The value of the mineral output from the six-county study area was $18,695,000 or 9 percent of the State's total mineral output. There were 2,100 workers engaged in mineral activities in 1950. In 1960, there were only 750 workers in mineral activities. The 750 workers represented only 1 percent of the total employment in the study area in 1960.

Value of Mineral Output, 1960

County	Minerals		Value of Output
Bartholomew	Stone		$ 533,000
Daviess	Clay, sand, gravel		261,000
Jackson	Clay, sand, gravel		204,000
Knox	Coal, sand, gravel		3,759,000
Lawrence	Stone, cement		10,066,000
Martin	Gypsum, clay, stone		3,187,000
		Subtotal	$18,010,000
Daviess	Crude petroleum		327,000
Knox	Crude petroleum		358,000
		Subtotal	$ 658,000
		Grand Total	$18,695,000

Manufacturing

Manufacturing accounted for about 29 percent of the total employment in the study area in 1960 which was an increase of only 2 percent over 1950 (See Table 2). However, value added by manufacture in 1958 totaled $184,400,000, an increase of 26 percent over 1954 as measured in constant dollars.

The distribution of manufacturing plants according to industry and employee size is shown in Table 3. Over half of the plants employed less than 20 people in 1960, but according to the 1958 Census of Manufactures, there was one plant in the area which employed over 1,000 employees. Over 75 percent of manufacturing employment was in the manufacture of durable goods. The non-electrical machinery industry employment more than doubled between 1950 and 1960, and with 5,526 employees in 1960, employed more than double the number of employees of any other industry in the durable goods category. Each of those industries, however, employed at least 1,100 employees. Food and kindred products and apparel accounted for the majority of employment in the non-durable goods category.

Table 4 summarizes the manufacturing plant information from the 1958 Census of Manufactures in each county and indicates the possible high water intake plants and potential waste producers. All plants are included which had over 100 employees and whose 4-digit Standard Industrial Classification code industry is included in the listing of industries with an intake of over 20 million gallons per year in the Industrial

Table 2

Industrial Labor Force
Clifty Creek Reservoir Project
1950 - 1960

	1950	% of C.E.[a]	1960	% of C.E.[a]
Total Civilian Employment	68,219	100.0	72,725	100.0
Agriculture	12,795	18.8	11,755	16.2
Mining	2,069	3.0	748	1.0
Construction	3,256	4.8	3,843	5.3
Non-Commodity Industries	31,542	46.2	35,038	48.2
Transportation[b]	4,889	7.2	3,631	5.0
Trade	12,410	18.2	12,988	17.9
Finance	1,120	1.6	1,633	2.2
Services	7,538	11.0	10,200	14.0
Government	5,585	8.2	6,586	9.1
Manufacturing	18,557	27.2	21,341	29.3
Durables	13,635	20.0	16,228	22.3
Furniture-Lumber-Wood	2,522	3.7	1,960	2.7
Primary Metals	1,947	2.9	1,618	2.2
Fabricated Metals	915	1.3	1,161	1.6
Non-Electric Machinery	2,200	3.2	5,526	7.6
Electrical Machinery	2,993	4.4	2,323	3.2
Transportation Equipment	946	1.4	1,400	1.9
Miscellaneous	2,112	3.1	2,240	3.1
Non-Durables	4,922	7.2	5,113	7.0
Food & Kindred Products	1,642	2.4	1,495	2.1
Textiles	343	.5	13	----
Apparels	1,345	1.9	1,421	1.9
Printing & Publishing	321	.5	569	.8
Chemicals	547	.8	907	1.2
Miscellaneous	724	1.1	708	1.0

[a]Civilian Employment

[b]Includes Communications and Utilities

Table 3

Manufacturing Plants by
Major Industry and Employment Size
Clifty Creek Reservoir Project
1958

Industry	Employment Size (1-19)	Employment Size (20-99)	Employment Size (100-249)	Employment Size >250	Total	Percent of Total
Food & Kindred Products	29	17	5		51	19.2
Tobacco Products						
Textile Mill Products						
Apparel & Related Products	1	1	3	3	8	3.0
Lumber & Wood Products	31	6			37	14.0
Furniture & Fixtures	2	1		2	5	1.9
Paper & Allied Products	1	3	1	1	6	2.3
Printing & Publishing	19	7			26	9.8
Chemicals & Allied Products	4	2	2		8	3.0
Petroleum & Coal Products	2				2	.8
Rubber & Plastic Products		2			2	.8
Leather & Leather Products	1		1	3	5	1.9
Stone, Clay, & Glass Products	24	10	6	2	42	15.8
Primary Metals Products	3	1		2	6	2.3
Fabricated Metal Products	13	2	5		20	7.5
Non-Electric Machinery	15	5	1	3	24	9.0
Electrical Machinery	4	1	1	3	9	3.4
Transportation Equipment	2	1	4	2	9	3.4
Instruments & Related Products		1			1	.4
Miscellaneous Manufacturers	4				4	1.5
Total	155	60	29	21	265	100.0
Percent of Total	58.5	22.6	10.9	8.0	100.0	

Table 4

Summary of Manufacturing Plants
by Selected Counties, 1958
Clifty Creek Reservoir Project

SIC* Code	Industry Description	Number Plants	Employment Range	National Average Water Intake per Employee per Year in Gallons
	70 Plants			
	16 over 100 Employees			
BARTHOLOMEW COUNTY	**High Water Intake Plants**			
2033	Canned Fruits & Vegetables	1	100-249	552,000
3111	Leather Tanning & Finishing	1	100-249	655,000
3321	Gray Iron Foundries	1	500-999	489,000
2021	Creamery Butter	1	1-19	1,724,000
2094	Grease & Tallow	1	1-19	1,786,000
2421	Sawmills & Planning Mills	4	1-19	2,852,000
3273	Ready-Mixed Concrete	1	20-49	1,386,000
	Potential Waste Producers			
2011	Meat Packing	1	1-19	582,000
2015	Poultry Dressing	1	1-19	422,000
2015	Poultry Dressing	1	20-49	422,000
2026	Fluid Mills	1	1-19	356,000
	48 Plants			
	10 over 100 Employees			
JACKSON COUNTY	**High Water Intake Plants**			
2631	Paperboard Mills	1	100-249	8,840,000
2421	Sawmills & Planning Mills	7	1-19	2,852,000
2821	Plastic Materials	1	100-249	2,810,000
2834	Pharmaceutical Preparations	1	100-249	422,000
2892	Explosives	1	50-99	1,355,000
3273	Ready-Mixed Concrete	1	1-19	1,386,000
3717	Motor Vehicles & Parts	2	100-249	242,000
3717	Motor Vehicles & Parts	1	250-499	242,000
	Potential Waste Producers			
2011	Meat Packing	1	1-19	582,000
2015	Poultry Dressing	1	1-19	422,000
2026	Fluid Mills	1	50-99	356,000
2033	Canned Fruits & Vegetables	1	50-99	352,000
2042	Prepared Animal Feeds	1	20-49	584,000

*Standard Industrial Classification code.

Water Use Survey, 1958 Census of Manufactures. Plants with fewer than 100 employees are listed only if the industrial water intake per employee for their SIC category was very high, as shown in Table 4.

Non-Commodity Industries

Non-commodity employment in the study area made up about the same proportion of 48.2 percent total employment as it did in the state in 1960. It had increased 2 percent in ten years as compared to a 2.8 percent increase in the state, but there had been some changes in the importance of the different industries in the group. Transportation employment had declined 2.2 percent which service employment had increased 3 percent.

Income

Median family income in the study area was $4,616* in 1959, an increase of 86 percent over 1949. The state median family income in 1959 was $5,798 with an increase of 80 percent over 1949. Income in the area has been gaining on the higher income figure in the state but is still behind. However, because many of the families in the study area are associated with farming and get a portion of their income in farm products which are not included in the Census income figure, the real income in the area may not be as low as indicated by the difference between the state and study area figures.

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*Census of Population

Population

The growth of population for the decades from 1930 through 1960 has been on a modest upward sweep. The 1930 Census tabulated 163,926 residents in the study area, which comprised 5.1 percent of Indiana's population. At the end of 1960, population had climbed 18 percent since 1930 to 194,123, representing 4.2 percent of the state population. For those years (1930-1960) population growth in the basin outpaced the national growth rate of 11.4 percent, but was outdistanced by Indiana's growth rate of 22 percent.

The study area remains under-urbanized compared to the State of Indiana and to the Nation. At the 1960 Census, 43.6 percent, or 84,689, of the area's population was classified as urban; 56.4 percent was classified as rural-farm and rural non-farm. However, in Indiana urbanization was reported at 62.4 percent and the Nation urbanized sectors accounted for 70 percent of the population.

Of the seven cities in the economic study area, five have populations in excess of 10,000. Columbus is the largest city with a population of 20,778 in 1960.

Projected Economy

Projections of the economy of the Clifty Creek study area were derived from determining historical trend relationships between the study area and the state, and projecting those relationships using, as the basis, projections for the state prepared by the National Planning Association,

Washington, D. C. Past trends were modified in accordance with judgment based on additional information. These projections are of a preliminary nature and may be modified, if necessary, upon receipt of the Arthur D. Little Company economic base study report for the Ohio River Basin

Employment Projections

Table 5 shows employment projections to 1976. Manufacturing employment is projected to increase. Employment in commodity production, however, will decline as a proportion of aggregate labor force. Non-commodity and service-utility industries will gain more prominence in employment size and in percentage share of the over-all labor force.

Population Projections

Population growth is projected to surpass past performance (See Figure II). The study area, though not expected to match national and state rates of growth, will experience population expansion. In 2010, the study is expected to number about 330,000 in population which is an increase of 37.5 percent compared to the 1960 Census of 240,000.

Table 6 lists projections for major urban districts within the basin. It is anticipated that future growth will concentrate in those areas where present population density is most pronounced.

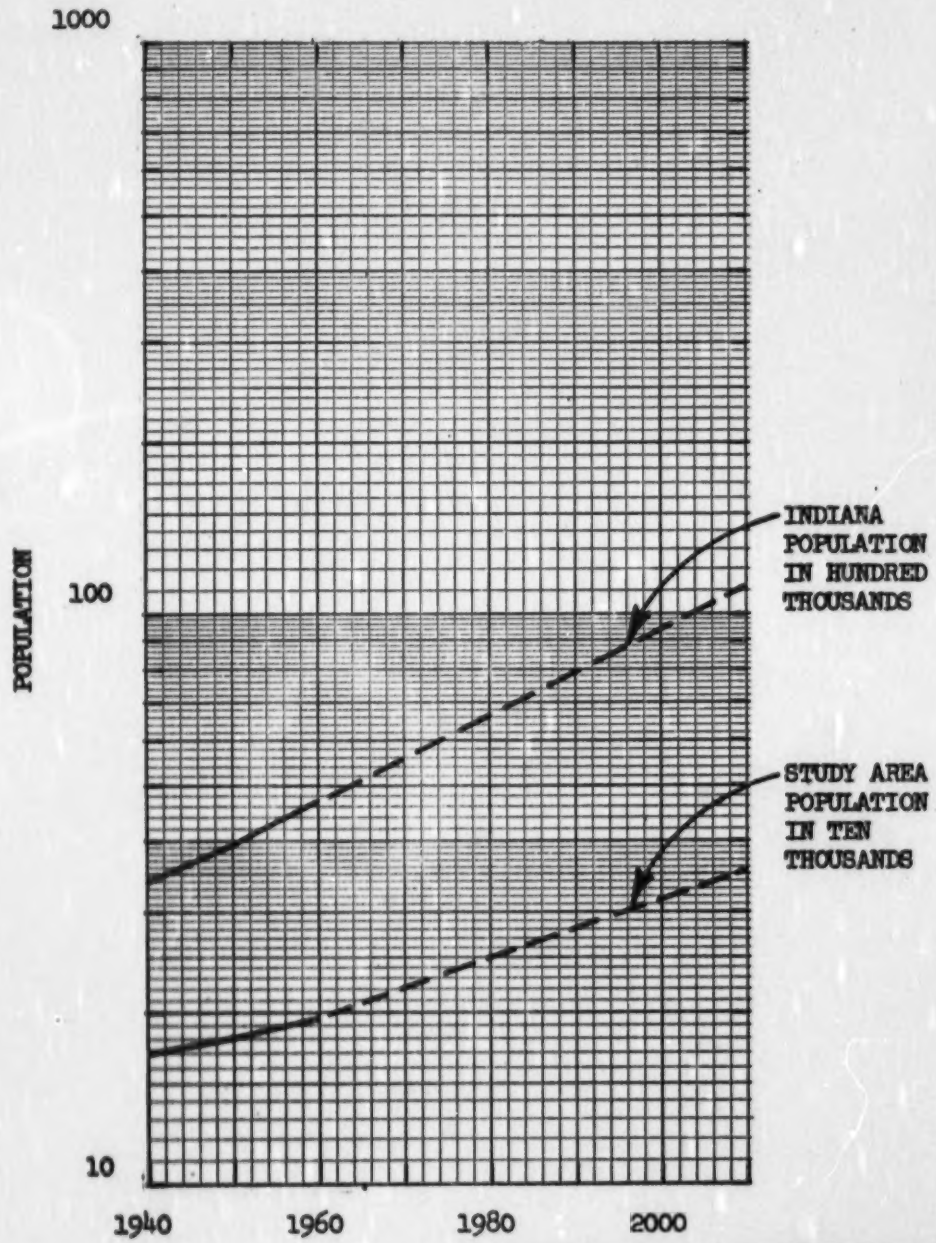
Table 5

Economic Projections
Clifty Creek Reservoir Project
1960 - 1976

	1960	% of C.E.[a]	1976	% of C.E.[a]
Total Civilian Employment	72,725	100.0	96,160	100.0
Agriculture	11,755	16.2	8,800	9.1
Mining	748	1.0	700	.7
Construction	3,843	5.3	6,500	6.8
Non-Commodity Industries	35,038	48.2	53,000	55.2
Transportation[b]	3,631	5.0	5,000	5.2
Trade	12,988	17.9	19,500	20.3
Finance	1,633	2.2	2,400	2.5
Services	10,200	14.0	16,700	17.4
Government	6,586	9.1	9,400	9.8
Manufacturing	21,341	29.3	27,160	28.2
Durables	16,228	22.3	21,350	22.2
Furniture-Lumber-Wood	1,960	2.7	1,800	1.9
Primary Metals	1,618	2.2	1,850	1.9
Fabricated Metals	1,161	1.6	1,500	1.6
Non-Electric Machinery	5,526	7.6	7,500	7.8
Electrical Machinery	2,323	3.2	3,500	3.6
Transportation Equipment	1,400	1.9	2,200	2.3
Miscellaneous	2,240	3.1	3,000	3.1
Non-Durables	5,113	7.0	5,810	6.0
Food & Kindred Products	1,495	2.1	1,900	2.0
Textiles	13	--	10	--
Apparels	1,421	1.9	700	.7
Printing & Publishing	569	.8	1,100	1.1
Chemicals	907	1.2	1,200	1.2
Miscellaneous	708	1.0	900	.9

[a]Civilian Employment

[b]Includes Communications and Utilities



CLIFTY CREEK RESERVOIR REPORT

POPULATION PROJECTIONS

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

OHIO RIVER BASIN PROJECT
EVANSVILLE, INDIANA FIELD STATION

FIGURE II

Table 6

Population Projections
Clifty Creek Reservoir Project
1976 - 2010

	1950	% Change	1960	% Change	1976	% Change	2010
United States	151.3 mil.	18.5	179.3 mil.	28.3	230.0 mil.	87.0	430.0 mil.
State of Indiana	3.9 mil.	20.5	4.7 mil.	34.0	6.2 mil.	77.5	11.0 mil.
Study Area (Bartholomew, Daviess, Jackson, Knox, Lawrence, and Martin Counties)	180,000	7.8	194,000	23.7	240,000	37.5	330,000
Columbus Township (Incl. Columbus)	23,000	30.4	30,000	33.3	40,000	82.5	73,000
Columbus Only	18,000	16.7	21,000	42.9	30,000	100.0	60,000
Jackson Township (Incl. Seymour)	12,000	8.3	13,000	38.5	18,000	66.7	30,000
Seymour Only	10,000	20.0	12,000	33.3	16,000	68.8	27,000

VI. WATER REQUIREMENTS

As the population increases and industrial growth occurs, greater demands will be made for water. Hence, the growth projected in the preceding section supports the projections of increased water needs.

Past and Present Water Use

Municipal

Presently there are no public water supplies within the basin, but there are three municipalities just outside of the basin and within its influence that do have public water supplies. These communities are Columbus, Greensburg, and Hope. Their water use is listed in Table 7.[6]

Industrial

In the past, the major portion of industrial water consumption has been supplied from municipal systems. Presently there are a few moderately heavy industrial water users that have their own water systems. These industries obtain their supplies from well fields. No data are available at this time from self-supplied industries pertaining to the quantity or the pre-treatment of water supplies for industrial use.

Water Pollution Control

The communities of Columbus and Greensburg are the only municipalities within the influence of the Clifty Creek Basin that presently have waste treatment facilities. Table 8[7] lists information pertaining to these treatment facilities.

Table 7

Municipal Water Systems[6]
Clifty Creek Reservoir Project

Municipality	1960 Pop.	Source	Treatment	Rated Plant Capacity (mgd)	Average Plant Output (mgd)	Demand (gpcd)
Columbus	20,778	Wells	Iron removal Filtration Chlorination	6.00	3.50	168
Greensburg	6,605	Wells and Flatrock Creek	Iron removal Filtration Chlorination	2.00	1.00	151
Hartsville	399	(No municipal water system)				
Hope	1,489	Wells	Chlorination	0.5	0.08	54

Table 8

Municipal Waste Treatment[7]
Clifty Creek Reservoir Project

Municipality	1960 Pop.	Design Flow (mgd)	Average Flow (mgd)	Treatment	Discharge to
Columbus	20,778	5.30	3.89	Activated sludge Chlorination	East Fork, White River
Greensburg	6,605	0.80	0.70	Activated sludge Chlorination	Sand Creek

At the present time the community of Hope has no waste water treatment works. However, the town does have a combined sewer system which discharges the liquid wastes of the community into Haw Creek, a tributary of the East Fork, White River. It is expected that in the future, Hope will construct a municipal waste treatment plant that will discharge its effluent into Haw Creek.

It is expected that Greensburg will continue to discharge treated wastes to Sand Creek, a tributary of the East Fork of White River. Therefore, the municipal wastes of the town will present no area of concern for water quality control within the Clifty Creek Basin.

The community of Hartsville has no sewerage system at this time, but it is expected that the community will provide waste treatment facilities when its waste load becomes sufficiently great to compel construction. The effluent from such a plant could conceivably enter the proposed reservoir.

Columbus now discharges its treated effluent into the East Fork, White River. This plant also treats the wastes from Bakalar Air Force Base located north of the city of Columbus.

Several industries within the study area, but outside of the Clifty Creek drainage basin, have their own treatment facilities. The discharges from these treatment works do not enter into the watershed of Clifty Creek.

Existing Sources

As previously mentioned, there are no municipal water systems within the basin itself but for those communities near the basin, wells

are the chief source of public water supply. Generally ground water of good quality and dependable quantity becomes increasingly difficult to obtain proceeding upstream in the basin.[8] Information furnished by the U. S. Geological Survey indicates that the ground water is pumped from sand and gravel and bedrock aquifers. The bedrock aquifers are usually of limestone and yield from less than 20 to more than 100 gpm (gallons per minute) with a dissolved solids total of less than 400 mg/l (milligrams per liter). The sand and gravel aquifers yield from 20 to more than a 1000 gpm with a dissolved solids total of less than 350 mg/l.

A detailed study of the availability of ground water at Columbus will be required before a more accurate statement can be made concerning the uses of ground water in that area.

Columbus, prior to 1951, obtained its water supply from the East Fork, White River. The change to ground water supplies was made due to the savings in cost of building a new iron removal plant and utilizing wells as compared to remodeling of the then existing obsolete surface water treatment plant. The maximum dependable draft from the present well field is reported to be about 6.0 mgd[6] from sand and gravel aquifers.

The community of Hope obtains its ground water from sand and gravel and bedrock aquifers. This present well system has an estimated maximum dependable draft of 0.50 mgd.[6] This amount is becoming insufficient to meet Hope's increasing demands.

Twelve miles northeast of the proposed reservoir and just outside of the Clifty Creek Basin is the community of Greensburg. The public water system is supplied from wells located in sand and gravel and bedrock aquifers, and an impoundment of Flatrock Creek. Impounded safe yield and the maximum dependable ground water draft has been recorded as 2.0 mgd and 1.0 mgd respectively.[6]

The ranges of raw water quality for the municipalities of Columbus, Greensburg, and Hope are listed in Table 9.[9]

Additional Water Needs

Municipal

The water demand for the communities in or near the Clifty Creek Basin will vary with the economy of the area and with the availability of water. Table 10 lists the communities and shows estimated future per capita and municipal use. This table is based upon the best estimates of water use that can be made at this time. If more detailed and reliable data become available, it may become necessary to revise this tabulation.

Table 10 includes such light industrial water users that may be expected to be served from municipal supplies.

Future population figures for the communities of Hartsville and Hope are not based upon any economic factors and are not to be inferred as population projections or predictions.

Table 9

Quality of Municipal Water Supplies
(Raw Water) within the Influence of the
Clifty Creek Reservoir Project

Municipality		Columbus	Greensburg Surface Water*	Greensburg Ground Water	Hope
ph		7.1	7.9	7.6	7.1
Color		0-15	30	0-35	0-5
Turbidity		7	2500	15	0-10
Hardness as CaCo3	(mg/liter)	320	132	450	280-410
Calcium as Ca	(mg/liter)	80		115	100
Magnesium as Mg	(mg/liter)	30		40	35
Sodium as Na	(mg/liter)	2		10	7
Potassium as K	(mg/liter)	1		1	1
Iron as Fe	(mg/liter)	1.3	2.6	2.7	0-0.3
Manganese as Mn	(mg/liter)	0.2		0.4	0
Alkalinity (total) as CaCO3	(mg/liter)	260	102	360	250-360
Chlorides as Cl	(mg/liter)	6	4	11	5-15
Sulfates as So4	(mg/liter)	50		85	55
Nitrates as N	(mg/liter)	- 1	- 2	- 2	0-4.4
Fluorides as F	(mg/liter)	0.1	0.3	0.3	0.1-0.5

*1 Sample

Table 10

Future Municipal Water Supply Requirements
Clifty Creek Reservoir Project

Municipality	Population			Per Capita Use (gpcd)			Total Municipal Use (mgd)		
	1960	1976	2010	1960	1976	2010	1960	1976	2010
Greensburg	6,605	9,000	15,000	151	175 to 200	200 to 225	1.00	1.7 to 1.8	3.0 to 3.4
Hartsville	339	560*	1,100*	--	75 to 100	125 to 150	--	0.04 to 0.06	0.1 to 0.2
Hope	1,489	2,100*	3,700*	54	75 to 100	125 to 150	0.08	0.15 to 0.2	0.5 to 0.6
Columbus T. (Incl. Columbus)	30,000	40,000	73,000	--	175 to 200	200 to 225	--	7.0 to 8.0	14.6 to 16.4
Columbus Only	20,778	30,000	60,000	168	175 to 200	200 to 225	3.50	5.3 to 6.0	12.0 to 13.5

*Not to be inferred as a population projection.

Industrial

The majority of industrial water needs will continue to be satisfied from municipal sources. If any industries using large volumes of water are attracted to the basin, the water use would increase at a rate greater than that computed for the municipal needs. The industrial needs for the larger communities of Columbus and Greensburg are listed in Table 11. These communities are within the influence of the Clifty Creek Basin and represent the locale where moderately large industrial water users would most likely locate. The tabulation for industrial water requirements is based upon the best estimates that can be made at the present time. Revision of this table may be required as further data become available.

Water Quality Objectives

The water quality objectives used as a basis for determination of need for storage for regulation of streamflow for purpose of water quality control are all related to the downstream land uses and instream uses of the waters. Where proper quality is not maintained, possible economic benefits may be foregone and the public health may be endangered. The objectives used in evaluating quality conditions in the East Fork, White River below Clifty Creek have been based on East Fork, White River's use as a source of raw water for Seymour, Indiana, preservation of aquatic life, and present and future general recreational use. Clifty Creek flows through a desirable residential area of Columbus, Indiana. If a waste treatment plant is built along Clifty Creek, there must be an adequate

Table 11

Industrial Water Requirements
Clifty Creek Reservoir Project

Community	Year		
	1960	1976	2010
Greensburg	--	0.6 to 0.7	1.3 to 1.5
Columbus	--	3.5 to 4.0	7.3 to 8.2
Total Industrial Need	0	4.1 to 4.7	8.6 to 9.7

quantity of good quality of receiving waters to accept the treated wastes, in order that the stream be esthetically acceptable and that no offensive odors be caused from further degradation of treated wastes.

The bacterial coliform content is not used as an objective which could be achieved by additional storage for regulation of streamflow. Chlorination of treated effluent is considered to be the cheapest solution. However, it should be recognized that not all wastes containing bacteria are collectable, for instance storm water overflows and street washings.

The distance (time of travel) between the waste treatment outfall and the nearest downstream water intake for municipal use must also be considered. Seymour, Indiana is approximately 27 miles downstream from Columbus, Indiana

In setting water quality objectives for streams for protection of aquatic life, mere survival is not enough. The minimum level selected should be suitable for the continuous maintenance of satisfactory fish life and fish food organisms. Objectives are therefore based upon the environmental requirements of the fish species present in the river. On the basis of Public Health Service studies in the Cincinnati area, it was concluded that for a well-rounded, warm water fish population, dissolved oxygen concentrations should not be below 5 mg/l for more than 8 hours per day of any 24-hour period.

Based upon the location of the raw water intake of Seymour, Indiana; the need to perpetuate a warm water fish habitat, the use of the East Fork, White River for general recreation, and the need to make Clifty

Creek esthetically acceptable to the residential population of Columbus, Indiana, the following water quality objectives have been used in determination of needs for storage:

1. Dissolved oxygen--a minimum of 4 mg/l and an objective of 5 mg/l.
2. Biochemical oxygen demand--not more than 5 mg/l.
3. The waters should not contain any toxic, taste-producing, or otherwise harmful substances, or organisms not readily and completely removable by ordinary water treatment. Raw waters should be free of excessive amounts of acid, microscopic organisms, and organic matters causing any interference with normal operation and efficiency of water treatment processes.
4. The waters released from the proposed Clifty Creek Reservoir should be of the best quality available in the reservoir during the critical hot summer and fall season. This objective could be achieved by the use of multi-level outlets; one in the upper levels, one at mid-depth, and one in the lower levels. Such discharges would assist in making Clifty Creek esthetically acceptable in the residential area of East Columbus, Indiana.

Water Quality Control

It is assumed in this preliminary evaluation that all municipal and industrial wastes discharged into Clifty Creek will be treated to the extent that 85 percent of the 5 day 20°C Biochemical Oxygen Demand (BOD) will be removed. Quantities of water required for water quality control are computed on the premise that such treatment will be provided.

Hartsville, as it begins to grow at a greater rate than in the past because of its location on the proposed reservoir, will require waste treatment facilities. This community would then discharge its adequately treated effluent into the watershed of the proposed reservoir.

The communities of Greensburg and Hope would continue to use other streams outside of the Clifty Creek Basin for the receiving of treated municipal wastes.

The area in Clifty Creek which will be of greatest concern after construction of the proposed reservoir will be below the mouth of Duck Creek and near the vicinity of Columbus, Indiana. The city is presently experiencing a growth toward the east and in the watershed of Clifty Creek. This eastward growth is expected to continue for some time. Consultants for the city have made a study and recommend that a waste water treatment plant be located on Clifty Creek to serve this growing area.[10]

Table 12 lists the minimum needs for water quality control in the Clifty Creek Basin.

Table 12

Water Quality Needs
Clifty Creek Reservoir Project

Municipality	Predicted Population			Estimated Sewage Flow (mgd)			Estimated Streamflow Regulation Requirements (mgd)		
	1960	1976	2010	1960	1976	2010	1960	1976	2010
Eastern Sector of Columbus	----	9,000	16,400	----	1.6 to 1.8	3.3 to 3.7	----	6.5 to 7.2	9.1 to 12.9
Columbus Township (Incl. Columbus and the Eastern Sector of Columbus)	30,000	40,000	73,000	----	10.5 to 12.0	22 to 25	----	48 to 55	103 to 113

About 27 miles downstream from Columbus on the East Fork, White River, the community of Seymour obtains its water supply from the river. Therefore, the quality of water in the East Fork, White River must be satisfactory for Seymour's need which may become as much as 6 mgd based on the predicted population for the year 2010. The flow release from the proposed reservoir augmented by the flows of downstream tributaries on Clifty Creek will supplement the natural flow of the East Fork, White River thereby providing more water for the dilution of wastes discharged at Columbus. This dilution should be sufficient to give the stream assimilative properties to provide satisfactory water quality for the Seymour water supply.

Summary of Needs

The following table, Table 13, gives a summary of the needs for water supply and for quality control in the Clifty Creek Basin.

The range of needs for water for quality control shown in Table 13 are for the summer season in Clifty Creek. An indication of the seasonal variation in these water quality needs is given in Table 14.

Plan for Supplying Future Requirements

The dependable ground water draft and impounded storage is expected to be sufficient to satisfy Greensburg's municipal needs although the industrial needs may be as much as 1.5 mgd by 2010. It is believed that enlargement of the existing well field or impoundment can supply this additional need.

Table 13

Summary of Needs
Clifty Creek Reservoir Project

Community	1960 (mgd)	1976 (mgd)	2010 (mgd)
Hartsville			
Municipal Water Supply	--	0.04 to .06	.1 to .2
Design Flow and Storage	--	--	--
Additional Need	--	0.04 to .06	.1 to .2
Greensburg			
Municipal Water Supply	1.00	1.7 to 1.8	3.0 to 3.4
Maximum Dependable Draft and Storage	3.0	3.0	3.0
Additional Need	--	--	0 to 0.4
Industrial Water Supply	--	0.8 to 0.9	1.5 to 1.7
Total Need	--	--	1.5 to 2.1
Hope			
Municipal Water Supply	0.08	.15 to .2	.5 to .6
Maximum Dependable Draft	0.5	0.5	0.5
Additional Need	--	--	0 to 0.1
Columbus (Columbus Township)			
Municipal Water Supply	3.5	7.0 to 8.0	14.6 to 16.4
Maximum Dependable Draft	6.0	6.0	6.0
Additional Need	--	1.0 to 2.0	8.6 to 10.4
Industrial Water Supply	--	3.5 to 4.0	7.3 to 8.2
Total Need	--	4.5 to 6.0	15.9 to 18.6
Columbus (Columbus Township)			
Quality Control Need			
To Receive Wastes from Eastern Sector of City	--	6.5 to 7.2	9.1 to 12.9
Design Flow (Clifty Creek Seven day once in ten years)[2]	0	0	0
Additional Need in Clifty Creek	--	6.5 to 7.2	9.1 to 12.9

Table 13 (Continued)

Summary of Needs
Clifty Creek Reservoir Project

Community	1960 (mgd)	1976 (mgd)	2010 (mgd)
To Receive Wastes from Entire Columbus Area*	--	48 to 55	103 to 113
Design Flow (East Fork, White River at Columbus - Seven consecutive day once in ten years)[2]	49	49	49
Total Need for Quality Control	--	0 to 6	54 to 64
Water Needs from proposed reservoir and flow of downstream tributaries	--	6.5 to 7.2	9.1 to 12.9

*Draft on storage in the year 2010 to assure the above flows is estimated to be 11,000 acre-feet.

Table 14

Seasonal Variation in Water
Quality Control Needs
Clifty Creek Reservoir Project

Season	Minimum Seasonal Need in CFS	
	1976	2010
Winter	6	10
Spring	7	12
Summer	12	20
Fall	12	20

The community of Hope will most likely expand its well field to accommodate the future additional needs. However, if the community does choose surface supplies for its water needs, it could probably construct or utilize impoundments close to Hope more economically than it could use the proposed reservoir.

Columbus is expected to continue using ground water as long as dependable quantity and satisfactory quality exist. If the need should arise for the return to surface water supplies, the city would utilize the East Fork, White River as its source. The minimum daily discharge since 1948 of the East Fork, White River at the gaging station at Columbus was 87 cfs. This quantity would provide ample supply for the city's needs.

Hartsville, as previously mentioned, does not have a municipal water system at the present time. As the community grows and reaches the point where a municipal water system becomes necessary, it could utilize the proposed reservoir as an impoundment for its water needs.

The streamflow requirements needed for quality control, as shown in Table 14, are based on the premise that smaller quantities of water are needed for quality control during the winter months. Because of lower temperatures, it is expected that inflow from downstream tributaries will contribute a greater amount of flow to Clifty Creek during the spring months with a resulting increase in flow available for assimilation of adequately treated waste water from the eastern sector of Columbus. Releases from the seasonal pool of the proposed Clifty Creek Reservoir would be increased from June, when the seasonal pool is scheduled to be filled, to the end of November, when the seasonal pool will be empty.

The quantity of water estimated for Clifty Creek is needed to prevent the adequately treated wastes from the future plant on Clifty Creek from degrading the water quality of that stream so that it is esthetically undesirable through the reach expected to be heavily urbanized.

The releases from the proposed Clifty Creek Reservoir will enter the East Fork, White River about 2 miles downstream from the present Columbus disposal plant. At the mouth of Clifty Creek, the BOD loading on the East Fork, White River will be the same whether one or two sewage plants are used for Columbus.

Because of the need for satisfactory water supply for Seymour, a sufficient flow in the river is necessary to assimilate properly treated wastes from Columbus. Even though 85 percent of the BOD is removed from the wastes, additional water is needed for quality control. It is anticipated that the quantity of flow available from releases of the seasonal pool will provide the additional flow unless Columbus changes its source of supply to the East Fork, White River as its sole source. In that event, a higher degree of treatment of wastes may be required or a greater quantity of water will be needed for quality control purposes because of decrease in the water remaining in the river.

The time available for this report has not permitted a study to establish a definite need in specific amounts of additional water for quality control purposes in the East Fork, White River as a result of Columbus utilizing the river as a water supply source. That need has not, therefore, been considered at this time in estimating future requirements.

VII. BENEFITS OF STORAGE

Evaluation Method

Due to time limitations, the study reported herein is a preliminary appraisal of needs for water supply and for water quality control. It has been determined that on the basis of presently available information, existing sources for water will be sufficient to meet the anticipated future needs of Columbus for municipal and industrial purposes. For that reason, only water quality control needs in the Columbus area is considered further in the evaluation.

Owing to the distance from the proposed reservoir to Greensburg, it is believed on the basis of presently available information that Greensburg can expand its present source of supply more economically than it can obtain water from the proposed reservoir.

The community of Hope, which is situated adjacent to and northeast of the basin, is expected to require additional water by the year 1976; but it is believed the existing well field can be enlarged sufficiently for the anticipated needs. If surface supplies become necessary, an impoundment closer to Hope will prove to be more economical than will the use of Clifty Creek Reservoir. If Hope did elect to use the proposed reservoir for a source of supply, its needs would be so small as to be insignificant with respect to reservoir storage computation. Therefore, the needs of that community are not considered further in this evaluation.

Hartsville, which is situated adjacent to the proposed reservoir site, presently has no municipal supply. If this community should elect to use a surface water source from the reservoir, its expected rate of consumption would be small and would have little effect upon the water storage needs that are considered in the reservoir design.

In view of the above water supply conditions, water for quality control needs in the Columbus area is the determining factor in the evaluation of benefits. The benefits that will result from the storage of water will equal the difference in cost of adequate waste treatment with one treatment plant, a lift station at Clifty Creek, and a trunk sewer from the lift station to the sewage treatment plant as compared to the cost of two sewage treatment plants, one of which would be on Clifty Creek.

Alternate Plans

Two general procedures of disposing of adequately treated wastes from Columbus have been considered. These approaches to the problem are indicated below.

A. Provide a lift station and trunk sewer to the main Columbus sewage treatment plant on the East Fork of White River.

B. Construct a sewage treatment plant on Clifty Creek to eliminate the need for the lift station, trunk sewer, and pumping costs. This would require a sufficient flow in Clifty Creek for water quality control purposes.

Alternate B affords two choices of obtaining water for quality control purposes. Plan B-1 would provide water for quality control from a single purpose reservoir upstream from the critical area which is downstream from the mouth of Duck Creek. Plan B-2 would provide water for quality control from the proposed multipurpose Clifty Creek reservoir.

Plan A would require treatment of all wastes in a central sewage treatment plant that would discharge into the East Fork of White River. As discussed previously, the flow of the East Fork, White River at Columbus is not sufficient to afford proper assimilation of adequately treated wastes from Columbus if the anticipated water supply is taken from the river in the year 2010. A quantity of water which will assure 5 mg/l of dissolved oxygen is also necessary to provide water for quality control in the river between Columbus and Seymour. This quantity would assure a proper quality for the raw water supply for Seymour, Indiana.

Plan A would afford less water for quality control than Plan B unless a similar amount of storage to that afforded by Plan B were provided for increasing minimum flows. Plan A also would require the installation of a lift station in the eastern sector of Columbus that now is developing along Clifty Creek, and it would require the installation of a trunk sewer from the lift station to the central treatment plant. This construction has been estimated to cost about $1,885,000 (1963 Construction Cost Index) more than a treatment plant situated on Clifty Creek.

Plan B-1 would decrease the BOD loading imposed on the East Fork, White River between Columbus and the mouth of Clifty Creek, and this would result in a better dilution of effluent from the main treatment plant. Also, because of the draft on storage during minimum stages of the Creek, the flow of the East Fork, White River below the mouth of Clifty Creek would be increased. This increase would result in some improvement of the water quality of the river downstream from the mouth of Clifty Creek.

Plan B-2 would offer the same advantages over Plan A as would Plan B-1. Because the needs for water for quality control can be satisfied from seasonal storage and because seasonal storage makes possible multiple use of identical storage space, the cost of storage required for Plan B-2 will be more economical than Plan B-1. For these reasons Plan B-2 is considered the most logical approach to satisfying the needs for water quality control in Clifty Creek and in East Fork, White River. The combination of seasonal storage and natural flow at the confluence of Duck Creek would assure the desired flows without increasing the actual construction cost of the proposed Clifty Creek Reservoir other than for a special multiple level outlet structure which would be needed to assure the discharge of the desired quality of water from the reservoir.

Water Supply Benefits

It is not anticipated at this time that any community except Hartsville will find it economically advantageous to use the proposed Clifty Creek

Reservoir as a source for municipal supply. Because Hartsville's needs would not cause any major revision in storage requirements inasmuch as its adequately treated waste water would be returned to the proposed reservoir, water supply benefits are not considered to be significant in this analysis.

Water Quality Control Benefits

Clifty Creek will need water for quality control in order to make possible a separate sewage treatment plant on Clifty Creek for the eastern sector of Columbus. A study for the city of Columbus made by an engineering consulting firm has indicated that a savings of about $1,885,000 in terms of 1963 dollars would result from the construction of this plant instead of a lift station and trunk sewer to the plant on the East Fork of White River. This savings adjusted for maintenance and operation costs and amortized at 3 percent for a period of 50 years would equal an annual cost of about $73,000 per year. Consequently, the minimum value of benefits to Clifty Creek from the release of water from the proposed Clifty Creek Reservoir would be $73,000 per year based on savings to Columbus, Indiana on elimination of trunk sewers and lift stations.

The release of this water from the proposed seasonal pool would increase the flow of the East Fork of White River and increase the assimilative capacity of that stream from the mouth of Clifty Creek to Seymour. As a result, the water quality of Seymour's source of supply would be improved. A single purpose reservoir with a storage capacity equivalent to that of the seasonal storage of the proposed Clifty Creek Reservoir,

about 11,000 acre-feet, should be expected to cost about $1,440,000 (1963 Construction Cost Index). Adjusted for operation and maintenance and amortized for 50 years, the $1,440,000 in cost would be equivalent to an annual cost of about $70,000. Thus, the minimum value of benefits to the East Fork, White River above Seymour would be about $70,000 per year. The total minimum value of annual benefits to Clifty Creek and to the East Fork, White River would be about $143,000.

The flows released from Clifty Creek also would improve the water quality over its present quality of the East Fork, White River downstream from Seymour and the White River to the Wabash River and, to a degree, the quality of the Wabash River to the Ohio River.

In the event that the entire water supply for the Columbus area is taken from the East Fork, White River, releases from the seasonal pool will not be sufficient to maintain the water quality at a level desirable for use as a water supply by Seymour. If conditions become changed to such an extent that more water is needed for quality control, a re-evaluation of benefits can be made. Additional flow can be obtained by converting some seasonal storage to a conservation pool. Because this measure would reduce flood control benefits to some small extent and is not needed at this time, it should await a definite need.

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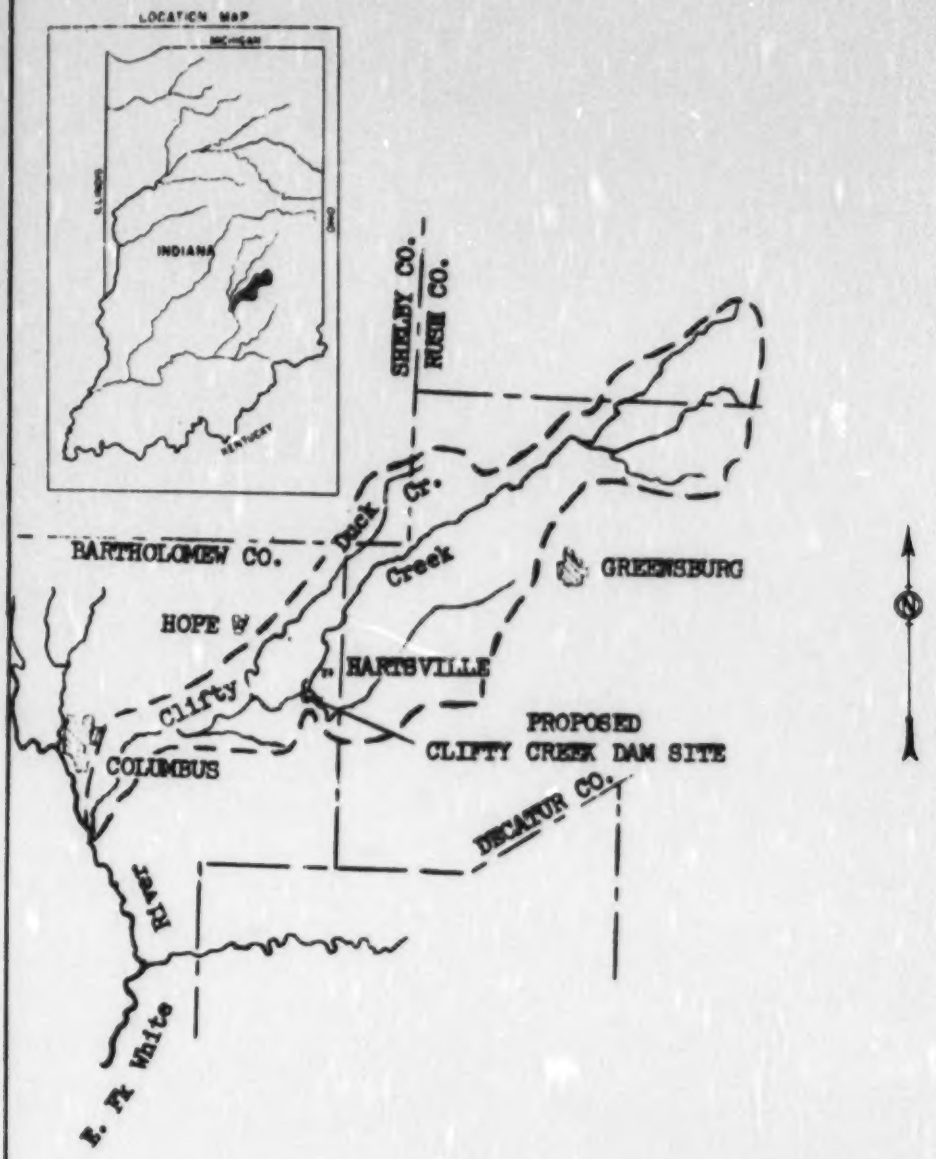

CLIFTY CREEK RESERVOIR REPORT

CLIFTY CREEK BASIN

STATE OF INDIANA

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

OHIO RIVER BASIN PROJECT
EVANSVILLE, INDIANA FIELD STATION

FIGURE I